

An examination of Figures 4-2 through 4-5 indicates that the maximum allowable EIRP levels required to satisfy the measured performance threshold of the GPS C/A-code receiver, across all of the operational scenarios, is a function of the PRF of the UWB device. Figure 4-2 shows that the maximum allowable EIRP levels corresponding to those UWB signal permutations with a PRF of 100 kHz. The EIRP levels shown in this figure for the unmodulated, 100% gated UWB waveform was computer based on a measured break-lock threshold. For the remaining UWB signal permutations represented in the figure, neither a break-lock nor a reacquisition could be measured for UWB power levels up to the maximum power available from the UWB signal generator. For these cases, the maximum UWB signal generator power level was used to compute the EIRP level. Thus the reported EIRP level represents a lower limit for these cases. That is, the actual maximum allowable EIRP level may higher than the level shown in the figure for these 100 kHz PRF UWB waveforms. From Figure 4-2, it can be observed that the maximum EIRP levels necessary to satisfy the measured performance threshold for the C/A-code GPS receiver over all of the operational scenarios considered in this study range from -73.2 to -26.5 dBW/MHz.

Figure 4-4 shows that the maximum allowable EIRP levels necessary to satisfy the measured performance thresholds over all of the operational scenarios considered in this study range from -98.6 to -67.0 dBW/MHz for those UWB signals employing PRFs of 1 MHz, 5 MHz, and 20 MHz, that are classified as noise-like in their interference effects to the GPS C/A-code receiver.

The data presented in Figure 4-5 shows that the maximum allowable EIRP levels range from -106.9 to -70.2 dBW over all of the operational scenarios considered for those UWB signals that are classified as CW-like in their interference effects on the GPS C/A-code receiver. These EIRP levels are based on the power in a single spectral line and in order to compare to the Part 15 level, it must be assumed that only a single spectral line appears in the measurement bandwidth.

Figures 4-6 and 4-7 present summary plots showing the maximum allowable EIRP calculated for the surveying operational scenarios assuming the use of the semi-codeless receiver architecture measured in this study. The analysis results are presented as a function of the various UWB signal structures examined. For the semi-codeless receiver architecture, the interference effects of all of the UWB signals examined are classified as either pulse-like or noise-like. Figure 4-6 shows that for those UWB signals examined with a PRF of 100 kHz, the calculated maximum level EIRP is above the current Part 15 emission level (i.e. no additional attenuation is necessary) with one exception: the 20% gated, 2% relative dithered signal.

Figure 4-7 shows the for the PRF's of 1 MHz, 5 MHz, and 20 MHz, those UWB signal structures that were classified as noise-like, the maximum allowable EIRP level must be as much as 23 dB below the current Part 15 level to satisfy the measured performance threshold of the semi-codeless GPS receiver in the applicable operational scenarios. The measurements of the semi-codeless receiver indicate a relative immunity to CW-like interference effects. This is because the semi-codeless receiver architecture uses the P-code signal which, because of its longer code length, has essentially no spectral lines.

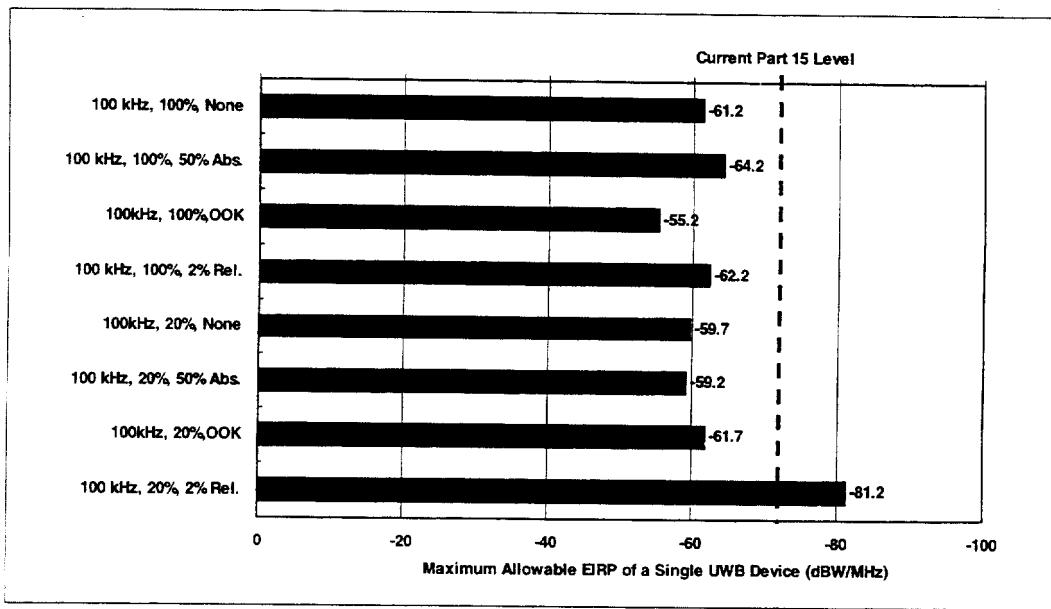


Figure 4-5. Maximum Allowable EIRP as a Function of UWB Signal Structure for the Semi-Codeless Receiver Architecture (Pulse-Like UWB Signals)

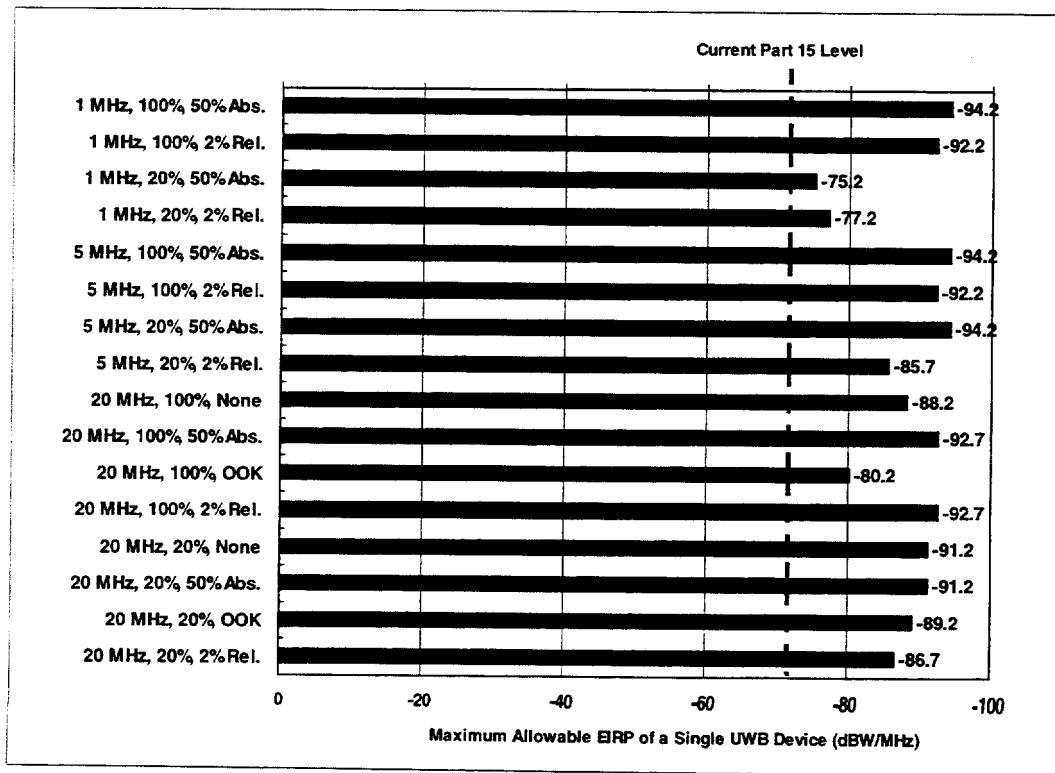


Figure 4-6. Maximum Allowable EIRP as a Function of UWB Signal Structure for the Semi-Codeless Receiver Architecture (Noise-Like UWB Signals)

4.3 CONCLUSIONS

The data collected in this assessment demonstrates that when considered in potential interactions with GPS receivers used in applications represented by the operational scenarios considered in this study, some of the UWB signal permutations examined exceeded the measured GPS performance thresholds at EIRP levels well below the current Part 15 emission level. Likewise, other UWB signal permutations (e.g., the 100 kHz PRF UWB signals) only slightly exceeded, and in some cases did not exceed, the measured GPS performance thresholds when considered in potential interactions with GPS receivers defined by the operational scenarios considered as a part of this study.

The following general conclusions were drawn based on the findings of this study:

- 1) The GPS receiver performance thresholds measured within this study are consistent with the interference protection limits developed within national and international GPS study groups.
- 2) When multiple noise-like UWB signals with equivalent power levels at the GPS receiver input are considered, the effective aggregate signal level in the receiver IF bandwidth is determined by adding the average power of each of the UWB signals.
- 3) Within the limitations of this study (i.e., the available number of UWB signal generators), it was found that when multiple CW-like UWB signals are considered, the effective aggregate interference effect to a C/A-code GPS receiver is the same as that of a single CW-like signal. The interference mechanism is a result of the alignment of a UWB spectral line with a dominant GPS C/A-code line.
- 4) The CW-like interference effect is not applicable to the semi-codeless receiver examined when operating in the dual frequency mode.
- 5) A GPS antenna does not offer any additional attenuation to that portion of a UWB signal within the GPS frequency band.
- 6) For those UWB signals examined with a PRF of 100 kHz, maximum permissible EIRP levels between -73.2 and -26.5 dBW/MHz are necessary to ensure EMC with the GPS applications defined by the operational scenarios considered within this study.
- 7) For those UWB signals examined with a PRF of 1 MHz, the maximum allowable EIRP levels necessary to achieve EMC with the GPS receiver applications considered in this study range from -70.2 to -104.3 dBW for the CW-like (unmodulated) UWB waveforms, and -57.6 to -91.6 dBW/MHz for the noise-like (modulated and/or dithered) UWB waveforms.
- 8) For those UWB signals examined with a PRF of 5 MHz, the maximum allowable EIRP levels necessary to ensure EMC with the GPS receiver applications considered in this study range from

-70.7 to -106.1 dBW for the CW-like (non-dithered) UWB waveforms, and from -49.6 to -97.6 dBW/MHz for the noise-like (dithered) UWB waveforms.

9) For those UWB signals examined with a PRF of 20 MHz, the maximum allowable EIRP levels required to ensure EMC with all of the GPS receiver applications considered in this study range from -71.0 to -106.9 dBW for the CW-like (non-dithered) UWB waveforms, and from -60.0 to -98.6 dBW/MHz for the noise-like (dithered) UWB waveforms.

It must be noted that these results are applicable only to those UWB signal permutations examined within this study and to those applications of GPS that are defined by the operational scenarios presented for consideration herein.

APPENDIX A

Derivation of Equations for Aggregate Effects Of UWB Devices in the Non-Precision Approach Landing Operational Scenario

This appendix provides the derivation of the equations used to compute the aggregate effects of UWB devices in the non-precision approach operational scenario. The parameters used to derive the equations are shown in Figure A-1.

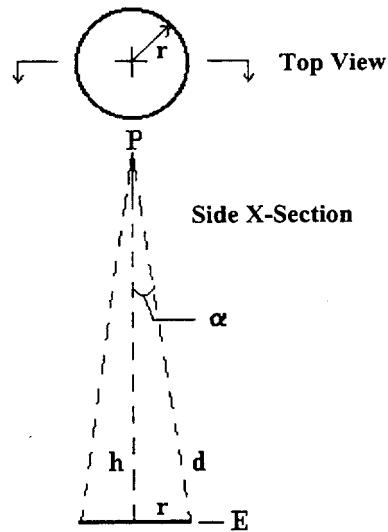


Figure A-1

The parameters in Figure A-1 are defined as:

Point P is the airborne GPS receiver antenna;

Surface E is the plane containing the interfering sources;

h is the minimum distance from point P to plane E

d is the distance from points on plane E whose propagation loss differs from the minimum loss at distance h by a fixed pathloss ratio LR;

r is the radius circle containing the points of the fixed pathloss ratio; and
 α is the angle between lines h and d.

Let $d/h = (LR)^{0.5}$

Then

$$d^2 = r^2 + h^2 = h^2(LR)$$

$$r^2 = h^2(LR) - h^2$$

$$r^2 = h^2(LR-1)$$

The radius of the circle containing the interfering sources is given by:

$$r = h(LR-1)^{0.5}$$

To derive the equation for computing the angle α use the trigonometric relationship for the cosine:

$$\cos \alpha = h/d$$

$$\alpha = \cos^{-1}(h/d) = \cos^{-1}(1/(LR)^{0.5})$$

The pathloss is proportional to $20 \log d = 20 \log(h(LR)^{0.5})$. This can be rewritten as

$$20 \log d = 20 \log h + 10 \log LR$$

Appendix B

Results of Spreadsheet Analysis Program

Operational Scenario: Terrestrial GPS Receiver and Single UWB Device
GPS Receiver Architecture: C/A-code

Broadband Noise										UWB										GPS	
UWB	PRF	Gating	UWB	Mod	I _{max} (dBW/MHz)	H _{gps} (m)	H _{uwB} (m)	H _{sep} (m)	Theta (deg)	Gr (dBic)	D _{min} (m)	L _p (dB)	L _{mult} (dB)	L _{allot} (dB)	L _{man} (dB)	L _{bA} (dB)	L _{sm} (dB)	UWB EIRP (dBW/MHz)	Receiver Criteria	RQT	
1 MHz	100%	None	-134.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-95.1		BL		
5 MHz	100%	None	-143.7	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-104.3		BL		
20 MHz	100%	None	-145.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-106.1		BL		
5 MHz	20%	None	-145.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-105.6		BL		
20 MHz	20%	None	-145.2	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-105.8		BL		
5 MHz	100%	OOK	-145.8	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-106.4		BL		
20 MHz	100%	OOK	-144.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-105.1		BL		
5 MHz	20%	OOK	-144.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-105.1		BL		
20 MHz	20%	OOK	-144.2	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-104.8		BL		
5 MHz	100%	OOK	-146.3	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-106.9		BL		
20 MHz	20%	OOK	-146.3	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-106.9		BL		
UWB	PRF	Gating	UWB	Mod	I _{max} (dBW/MHz)	H _{gps} (m)	H _{uwB} (m)	H _{sep} (m)	Theta (deg)	Gr (dBic)	D _{min} (m)	L _p (dB)	L _{mult} (dB)	L _{allot} (dB)	L _{man} (dB)	L _{bA} (dB)	L _{sm} (dB)	UWB EIRP (dBW/MHz)	Receiver Criteria	RQT	
100 kHz	100%	None	-112.6	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-73.2		BL		
100 kHz	20%	None	-106.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-67.1		DNBL		
1 MHz	20%	None	-97.6	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-58.2		DNBL		
100 kHz	100%	OOK	-102.6	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-63.2		DNBL		
1 MHz	100%	OOK	-121.2	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-81.8		BL		
100 kHz	20%	OOK	-109.4	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-70.0		DNBL		
1 MHz	20%	OOK	-101.1	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-61.7		DNBL		
100 kHz	100%	50% Abs.	-100	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-60.6		DNBL		
1 MHz	100%	50% Abs.	-113	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-73.6		RQT		
5 MHz	100%	50% Abs.	-137	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-97.6		RQT		
20 MHz	100%	50% Abs.	-138	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-98.6		RQT		
100 kHz	100%	2% Rel.	-100	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-60.6		DNBL		
1 MHz	100%	2% Rel.	-131	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-91.6		RQT		
5 MHz	100%	2% Rel.	-136.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-97.1		RQT		
20 MHz	100%	2% Rel.	-136	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-96.6		RQT		
100 kHz	20%	50% Abs.	-107	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-67.6		DNBL		
1 MHz	20%	50% Abs.	-97.5	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-58.1		DNBL		
5 MHz	20%	50% Abs.	-105	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-65.6		RQT		
20 MHz	20%	50% Abs.	-135	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-95.6		RQT		
100 kHz	20%	2% Rel.	-107	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-67.6		RQT		
1 MHz	20%	2% Rel.	-97	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-57.6		DNBL		
5 MHz	20%	2% Rel.	-89	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-49.6		RQT		
20 MHz	20%	2% Rel.	-133	3	3	2	0	0	2	42.4	0	3	0	0	0	0	-93.6		RQT		

BL - Break-Lock

RQT - Reacquisition Time

DNBL - Did not break-lock at the maximum UWB generator signal power

Operational Scenario: Terrestrial GPS Receiver and Multiple UWB Device (Outdoor Operation)

GPS Receiver Architecture: C/A-code		Single Entry GPS Receiver Criteria														
Broadband Noise	UWB PRF Gating	Imax (dBW/MHz)	Hgps (m)	Huwb (m)	Hsep (m)	Theta (deg)	dBIC (m)	Dmin (m)	Lp (dB)	Lmult (dB)	Lallot (dB)	Lman (dB)	Laf (dB)	Lsm (dB)	UWB EIRP (dBW/MHz)	UWB EIRP (dBW)
1 MHz	UWB Mod.	100%	-143.7	3	10	0	0	10	56.4	6	3	0	0	0	-93.4	BL
5 MHz	UWB Mod.	100%	-145.5	3	3	10	0	0	10	56.4	0	3	0	0	-95.2	BL
20 MHz	UWB Mod.	100%	-145	3	3	10	0	0	10	56.4	0	3	0	0	-94.7	BL
5 MHz	UWB PRF Gating	20%	-145.2	3	3	10	0	0	10	56.4	0	3	0	0	-94.9	BL
20 MHz	UWB PRF Gating	20%	-145.8	3	3	10	0	0	10	56.4	0	3	0	0	-95.5	BL
5 MHz	UWB PRF Gating	100%	-144.5	3	3	10	0	0	10	56.4	0	3	0	0	-94.2	BL
20 MHz	UWB PRF Gating	100%	-144.5	3	3	10	0	0	10	56.4	0	3	0	0	-94.2	BL
5 MHz	UWB PRF Gating	20%	-144.2	3	3	10	0	0	10	56.4	0	3	0	0	-93.9	BL
20 MHz	UWB PRF Gating	20%	-146.3	3	3	10	0	0	10	56.4	0	3	0	0	-96.0	BL
100 kHz	UWB PRF Gating	100%	-112.6	3	3	10	0	0	10	56.4	0	3	0	0	-62.3	BL
100 kHz	UWB PRF Gating	20%	-106.5	3	3	10	0	0	10	56.4	0	3	0	0	-56.2	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	100%	-102.6	3	3	10	0	0	10	56.4	0	3	0	0	-53.3	DNBL
1 MHz	UWB PRF Gating	100%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	20%	-109.4	3	3	10	0	0	10	56.4	0	3	0	0	-59.1	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-93.7	NRQT
100 kHz	UWB PRF Gating	100%	-100	3	3	10	0	0	10	56.4	0	3	0	0	-49.7	DNBL
1 MHz	UWB PRF Gating	100%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
5 MHz	UWB PRF Gating	100%	-137	3	3	10	0	0	10	56.4	6	3	0	0	-92.2	RQT
20 MHz	UWB PRF Gating	100%	-138	3	3	10	0	0	10	56.4	6	3	0	0	-91.7	RQT
100 kHz	UWB PRF Gating	20%	-107	3	3	10	0	0	10	56.4	6	3	0	0	-56.7	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	0	3	0	0	-49.7	NRQT
5 MHz	UWB PRF Gating	20%	-136.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	RQT
20 MHz	UWB PRF Gating	20%	-136	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	20%	-50% Abs.	-107	3	3	10	0	0	10	56.4	6	3	0	-56.7	DNBL
1 MHz	UWB PRF Gating	100%	-50% Abs.	-100	3	3	10	0	0	10	56.4	0	3	0	-49.7	NRQT
5 MHz	UWB PRF Gating	100%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	RQT
20 MHz	UWB PRF Gating	100%	-136	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	20%	-50% Abs.	-107	3	3	10	0	0	10	56.4	6	3	0	-56.7	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	0	3	0	0	-49.7	NRQT
5 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	RQT
20 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	20%	-2% Rel.	-107	3	3	10	0	0	10	56.4	0	3	0	-56.7	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	0	3	0	0	-49.7	NRQT
5 MHz	UWB PRF Gating	20%	-136.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	RQT
20 MHz	UWB PRF Gating	20%	-136	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	20%	-50% Abs.	-107	3	3	10	0	0	10	56.4	6	3	0	-56.7	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	0	3	0	0	-49.7	NRQT
5 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	RQT
20 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
100 kHz	UWB PRF Gating	20%	-2% Rel.	-107	3	3	10	0	0	10	56.4	6	3	0	-56.7	DNBL
1 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	0	3	0	0	-49.7	NRQT
5 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	RQT
20 MHz	UWB PRF Gating	20%	-134.5	3	3	10	0	0	10	56.4	6	3	0	0	-90.2	NRQT
BL - Break-lock	RQT-Reacquisition Time												DNBL - Did not break lock at the maximum available UWB generator signal power			
	NRQT - Broadband Noise Reacquisition												NRQT			

Operational Scenario: Terrestrial GPS Receiver and Multiple UWB Device (Indoor Operation)
GPS Receiver Architecture: C/A-code

Single Entry GPS Receiver Criteria											
Broadband Noise	UWB PRF	UWB Mod.	UWB Gating								
1 MHz	100%	None	-143.7	3	10	5	54.5	3	8.6	55.0	0
5 MHz	100%	None	-145.5	3	10	5	54.5	3	8.6	55.0	0
20 MHz	100%	None	-145	3	10	5	54.5	3	8.6	55.0	0
5 MHz	20%	None	-145.2	3	10	5	54.5	3	8.6	55.0	0
20 MHz	20%	None	-145.8	3	10	5	54.5	3	8.6	55.0	0
5 MHz	100%	OOK	-144.5	3	10	5	54.5	3	8.6	55.0	0
20 MHz	100%	OOK	-144.5	3	10	5	54.5	3	8.6	55.0	0
5 MHz	20%	OOK	-144.2	3	10	5	54.5	3	8.6	55.0	0
20 MHz	20%	OOK	-146.3	3	10	5	54.5	3	8.6	55.0	0
1 MHz	100%	None	-112.6	3	10	5	54.5	3	8.6	55.0	0
100 kHz	20%	None	-106.5	3	10	5	54.5	3	8.6	55.0	0
1 MHz	20%	None	-134.5	3	10	5	54.5	3	8.6	55.0	0
100 kHz	100%	OOK	-102.6	3	10	5	54.5	3	8.6	55.0	0
1 MHz	100%	OOK	-134.5	3	10	5	54.5	3	8.6	55.0	0
100 kHz	20%	OOK	-109.4	3	10	5	54.5	3	8.6	55.0	0
1 MHz	20%	OOK	-134.5	3	10	5	54.5	3	8.6	55.0	0
100 kHz	100%	50% Abs.	-100	3	10	5	54.5	3	8.6	55.0	0
1 MHz	100%	50% Abs.	-134.5	3	10	5	54.5	3	8.6	55.0	0
5 MHz	100%	50% Abs.	-137	3	10	5	54.5	3	8.6	55.0	0
20 MHz	100%	50% Abs.	-138	3	10	5	54.5	3	8.6	55.0	0
100 kHz	100%	2% Rel.	-100	3	10	5	54.5	3	8.6	55.0	0
1 MHz	100%	2% Rel.	-134.5	3	10	5	54.5	3	8.6	55.0	0
5 MHz	100%	2% Rel.	-136.5	3	10	5	54.5	3	8.6	55.0	0
20 MHz	100%	2% Rel.	-136	3	10	5	54.5	3	8.6	55.0	0
100 kHz	20%	50% Abs.	-107	3	10	5	54.5	3	8.6	55.0	0
1 MHz	20%	50% Abs.	-134.5	3	10	5	54.5	3	8.6	55.0	0
5 MHz	20%	50% Abs.	-134.5	3	10	5	54.5	3	8.6	55.0	0
20 MHz	20%	50% Abs.	-134.5	3	10	5	54.5	3	8.6	55.0	0
100 kHz	20%	2% Rel.	-107	3	10	5	54.5	3	8.6	55.0	0
1 MHz	20%	2% Rel.	-134.5	3	10	5	54.5	3	8.6	55.0	0
5 MHz	20%	2% Rel.	-134.5	3	10	5	54.5	3	8.6	55.0	0
20 MHz	20%	2% Rel.	-134.5	3	10	5	54.5	3	8.6	55.0	0
BL - Break-lock											
RQT - Reacquisition Time											
DNBL - Did not break lock at the maximum available UWB generator signal power											
NRQT - Broadband Noise Reacquisition											

DNBL - Did not break lock at the maximum available UWB generator signal power
 NRQT - Broadband Noise Reacquisition

Operational Scenario: Navigation In Constrained Waterways GPS Receiver and Multiple UWBT Device (Indoor Operation) (I)

RQ7 - Reacquisition Time
DNBL - Did not break lock at the maximum available UWB
generator signal power
NRNOT - Broadband Noise Recognition

Operational Scenario: Navigation In Constricted Waterways GPS Receiver and Multiple UWB Device (Outdoor Operation) (I)
GRS Receiver Architecture: C/A-code

RQT - Reacquisition Time

DNBI - Did set **known** 6 / 10

EINGT : Did not break lock at the maximum UWB generator signal power
NBQT : Broadband Noise Recognition

Operational Scenario: Navigation In Constricted Waterways GPS Receiver and Multiple UWB Device (Indoor Operation) (I)

GPS Receiver Architecture: C/A-code

BOT : Beacons in Time

DNIBI | Did not | Did not | Did not | Did not

DNBL - Did not break lock at the maximum

Operational Scenario: Navigation In Constricted Waterways GPS Receiver and Multiple UWB Device (Outdoor Operation) (II)
GPS Receiver Architecture: C/A-code

		GPS Receiver Criteria: RQT										GPS Receiver Criteria: NRQT									
		UWB EIRP (dBW/MHz)					UWB EIRP (dBW/MHz)					UWB EIRP (dBW/MHz)					UWB EIRP (dBW/MHz)				
		I _{max} (dBW/MHz)	H _{gps} (m)	H _{uwb} (m)	H _{sep} (m)	Theta (deg)	G _r (dBiC)	D _{min} (m)	L _p (dB)	L _{mult} (dB)	L _{allot} (dB)	L _{man} (dB)	L _a (dB)	L _{sm} (dB)	UWB EIRP (dBW/MHz)						
Broadband Noise																					
UWB PRF	1 MHz	100%	None	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	5 MHz	100%	None	-143.7	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-79.2	-79.2
UWB PRF	20 MHz	100%	None	-145.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-81.0	-81.0
UWB PRF	5 MHz	20%	None	-145.2	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-80.5	-80.5
UWB PRF	20 MHz	20%	None	-145.8	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-80.7	-80.7
UWB PRF	5 MHz	100%	OOK	-144.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-81.3	-81.3
UWB PRF	20 MHz	100%	OOK	-144.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-80.0	-80.0
UWB PRF	5 MHz	20%	OOK	-144.2	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-80.0	-80.0
UWB PRF	20 MHz	20%	OOK	-146.3	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-79.7	-79.7
UWB PRF	1 MHz	100%	None	-112.6	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-81.8	-81.8
UWB PRF	100 kHz	20%	None	-106.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-48.1	-48.1
UWB PRF	1 MHz	20%	None	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-42.0	-42.0
UWB PRF	100 kHz	100%	OOK	-102.6	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	1 MHz	100%	OOK	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-38.1	-38.1
UWB PRF	100 kHz	20%	OOK	-109.4	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	1 MHz	20%	OOK	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-44.9	-44.9
UWB PRF	100 kHz	100%	Abs.	-100	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	1 MHz	100%	50% Abs.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-35.5	-35.5
UWB PRF	5 MHz	100%	50% Abs.	-137	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	20 MHz	100%	50% Abs.	-138	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-78.5	-78.5
UWB PRF	100 kHz	100%	2% Rel.	-100	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-79.5	-79.5
UWB PRF	1 MHz	100%	2% Rel.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-35.5	-35.5
UWB PRF	5 MHz	100%	2% Rel.	-136.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	20 MHz	100%	2% Rel.	-136	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-78.0	-78.0
UWB PRF	100 kHz	20%	50% Abs.	-107	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-77.5	-77.5
UWB PRF	1 MHz	20%	50% Abs.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-42.5	-42.5
UWB PRF	5 MHz	20%	50% Abs.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	20 MHz	20%	50% Abs.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	100 kHz	20%	2% Rel.	-107	7.5	3	51	-5.0	0	51.2	70.5	0	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	1 MHz	20%	2% Rel.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	5 MHz	20%	2% Rel.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
UWB PRF	20 MHz	20%	2% Rel.	-134.5	7.5	3	51	-5.0	0	51.2	70.5	6	3	3	0	0	0	0	0	-76.0	-76.0
BL - Break-lock																					

RQT - Reacquisition Time

DNBL - Did not break lock at the maximum

UWB generator signal power

NRQT - Broadband Noise Reacquisition

Operational Scenario: Railway GPS Receiver and Multiple UWB Device (Outdoor Operation)
GPS Receiver Architecture: C/A-code

		GPS Receiver Criteria												
		RQT						NRQT						
		L _{max} (dBW/MHz)	H _{gps} (m)	H _{uw} (m)	H _{sep} (m)	Theta (deg)	G _r (dBiC)	L _p (dB)	L _{min} (dB)	L _{af} (dB)	L _{ba} (dB)	L _{sm} (dB)	UWB EIRP (dBW/MHz)	Receiver Criteria
Broadband Noise	UWB	I _{max} (dBW/MHz)	H _{gps} (m)	H _{uw} (m)	H _{sep} (m)	Theta (deg)	G _r (dBiC)	L _p (dB)	L _{min} (dB)	L _{af} (dB)	L _{ba} (dB)	L _{sm} (dB)	UWB EIRP (dBW/MHz)	RQT
UWB	UWB Mod.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	0	-84.5
PRF	UWB Gating	None	-143.7	10	3	-45	-4.5	9.9	56.3	0	3	0	0	-88.9
1 MHz	100%	None	-145.5	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
5 MHz	100%	None	-145	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
20 MHz	100%	None	-145.2	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
5 MHz	20%	None	-145.8	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
20 MHz	20%	None	-144.5	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
5 MHz	100%	OOK	-144.5	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
20 MHz	100%	OOK	-144.2	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
5 MHz	20%	OOK	-144.2	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
20 MHz	20%	OOK	-146.3	10	3	-45	-4.5	9.9	56.3	0	3	0	0	BL
UWB	UWB	I _{max} (dBW/MHz)	H _{gps} (m)	H _{uw} (m)	H _{sep} (m)	Theta (deg)	G _r (dBiC)	L _p (dB)	L _{min} (dB)	L _{af} (dB)	L _{ba} (dB)	L _{sm} (dB)	UWB EIRP (dBW/MHz)	GPS Receiver Criteria
PRF	UWB Gating	None	-112.6	10	3	7	-45	-4.5	9.9	56.3	0	3	0	-57.8
100 kHz	100%	None	-106.5	10	3	7	-45	-4.5	9.9	56.3	0	3	0	BL
100 kHz	20%	None	-134.5	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	20%	None	-102.6	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
100 kHz	100%	OOK	-134.5	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	100%	OOK	-109.4	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
100 kHz	20%	OOK	-134.5	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	20%	OOK	-100	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
100 kHz	100%	50% Abs.	-134.5	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	100%	50% Abs.	-137	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
5 MHz	100%	50% Abs.	-138	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
20 MHz	100%	50% Abs.	-100	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	RQT
100 kHz	100%	2% Rel.	-134.5	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	100%	2% Rel.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
5 MHz	100%	2% Rel.	-136.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
20 MHz	100%	2% Rel.	-136	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	RQT
100 kHz	20%	50% Abs.	-107	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	20%	50% Abs.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
5 MHz	20%	50% Abs.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
20 MHz	20%	50% Abs.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
100 kHz	20%	2% Rel.	-107	10	3	7	-45	-4.5	9.9	56.3	0	3	0	DNBL
1 MHz	20%	2% Rel.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
5 MHz	20%	2% Rel.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
20 MHz	20%	2% Rel.	-134.5	10	3	7	-45	-4.5	9.9	56.3	4.8	3	0	NRQT
BL - Break-lock														

RQT - Reacquisition Time

DNBL - Did not break lock at the maximum UWB generator signal power

NRQT - Broadband Noise Reacquisition

Operational Scenario: Railway GPS Receiver and Multiple UWB Device
(Indoor Operation)
GGPS Receiver Architecture: C/A-code

RQT - Reacquisition Time

DNBL - Did not break lock at the maximum UWB generator signal power

NRQT - Broadband Noise Reacquisition

Operational Scenario: Surveying GPS Receiver and Single UWB Device GPS Receiver Architecture: Semi-Codeless

DL - Break-Lock

RQ1 - Did not break lock at the maximum UWB generator signal power

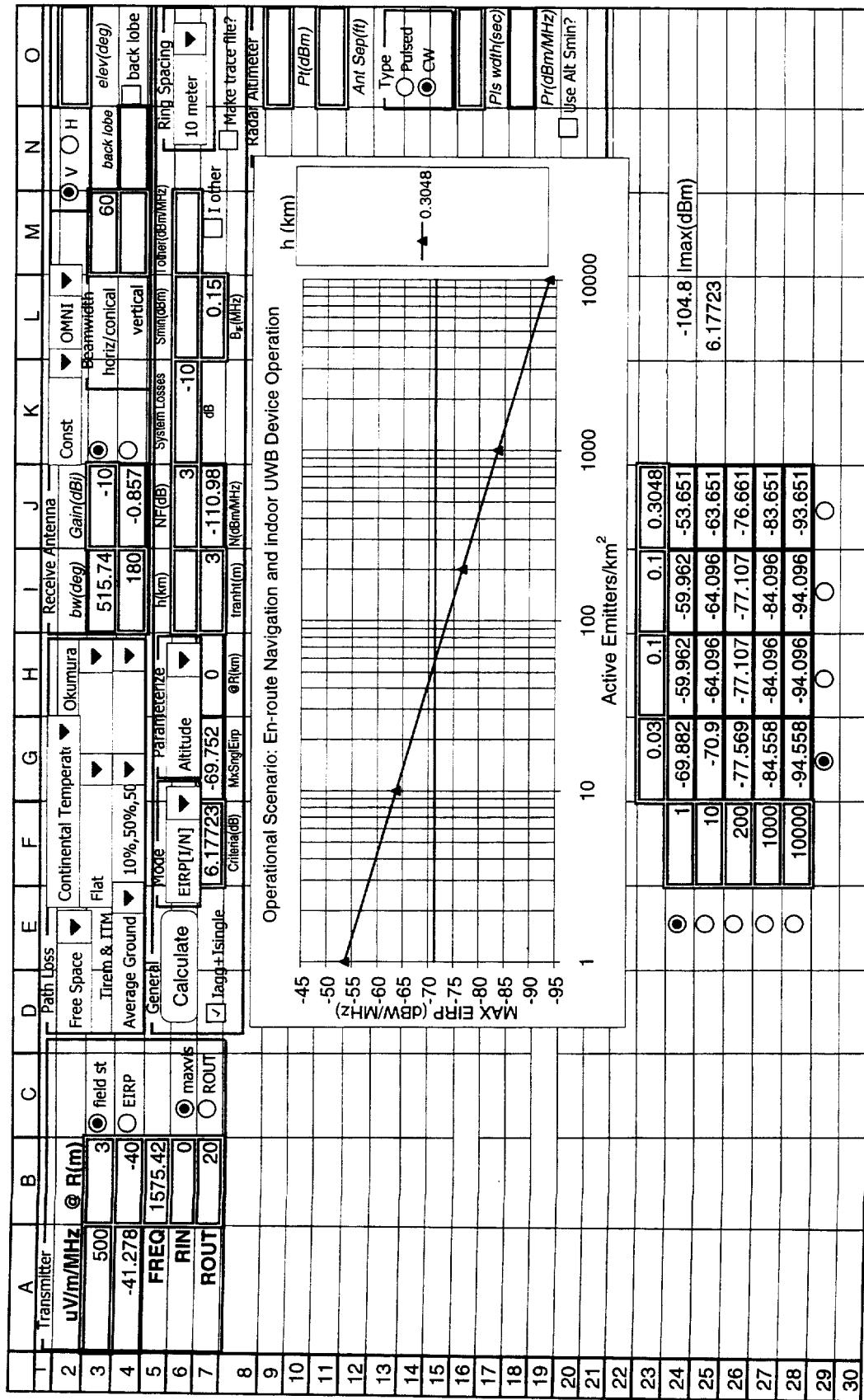
Operational Scenario: Surveying GPS Receiver and Multiple UWB Devices
GPS Receiver Architecture: Semi-Codeless

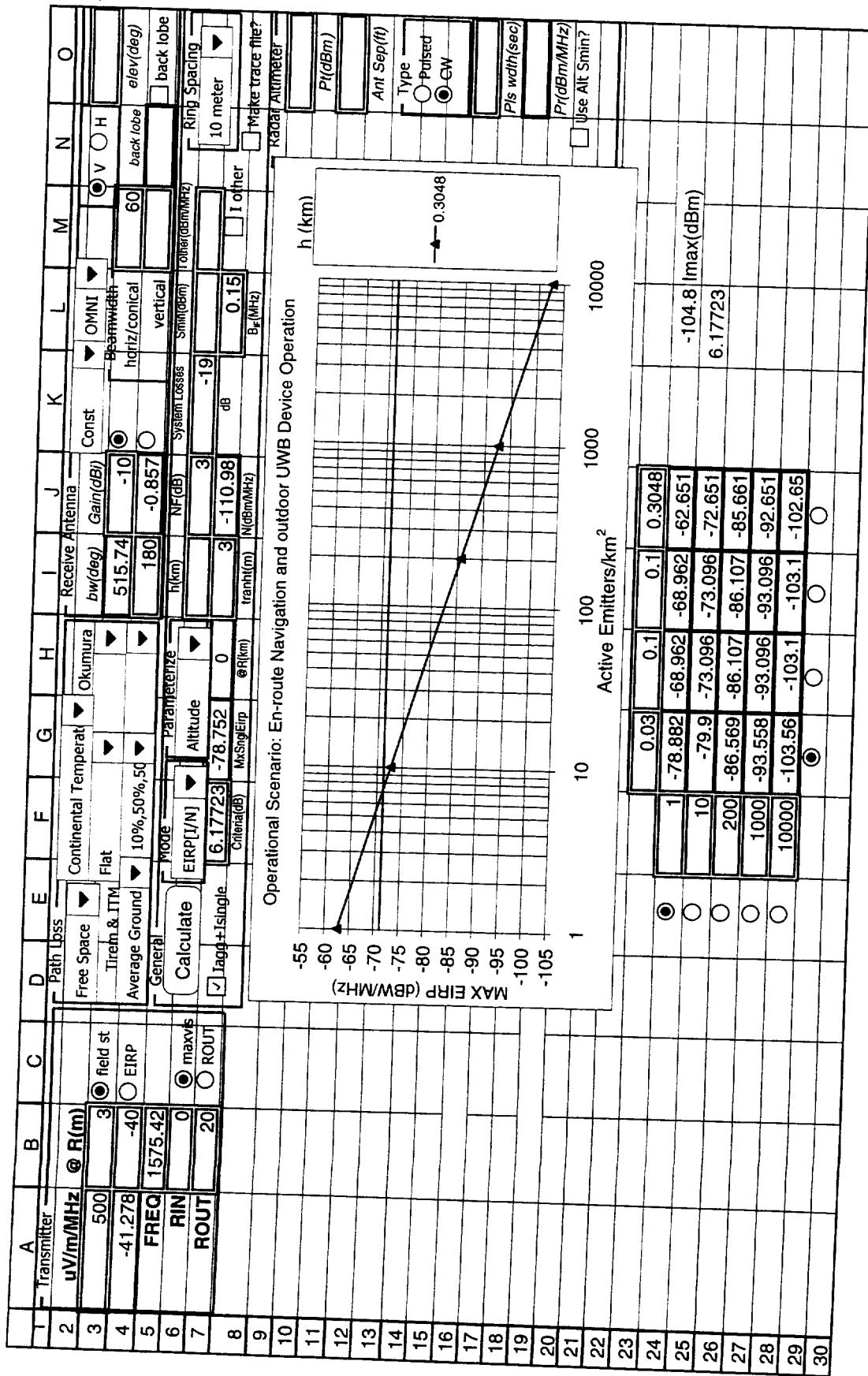
Operational Scenario: Aviation GPS Receiver Non-Precision Approach and Multiple UWB Devices
GPS Receiver Architecture: C/A code

RQT - Reacquisition Time

→ NBL - Did not break lock at the maximum UWB generator signal power

IRQT - Broadband Noise Reacquisition





Measurements to Determine Potential Interference to GPS Receivers from Ultrawideband Transmission Systems



report series

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Measurements to Determine Potential Interference to GPS Receivers from Ultrawideband Transmission Systems

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February 2001

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